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SOUTH PLUME GROUNDWATER EXTRACTION SYSTEM OPERATION AND MAINTENANCE MANUAL DRAFT SEPTEMBER 27, 1991

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South Plume Groundwater Extraction System Operation and Maintenance Manual Draft

Environmental Remedial Action Project
Fernald Environmental Management Project
Fernald, Ohio

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SOUTH PLUME
GROUNDWATER EXTRACTION SYSTEM
OPERATION AND MAINTENANCE MANUAL (DRAFT)

CONTENTS

CONTENTS (Continued)

SECTION 1

INTRODUCTION

1.1 Purpose and Description

This Operation and Maintenance Manual (O&M Manual) has been prepared to delineate a program of operation and maintenance activities associated with the groundwater extraction system for the south groundwater contamination plume (south plume) removal action at the Fernald Environmental Management Project (FEMP) near Fernald, Ohio. The south plume removal action is required pursuant to the 1990 Consent Agreement between the United States Environmental Protection Agency (USEPA) and the United States Department of Energy (DOE).

To facilitate more efficient design and construction, the south plume removal action has been divided into five parts:

Part 1) Alternative Water Supply
Part 2) Pumping and Discharge System
Part 3) Interim Advanced Wastewater Treatment System
Part 4) Groundwater Monitoring and Institutional Controls
Part 5) Groundwater Modeling and Geochemical Investigation.

An O&M Manual is needed to effectively operate the groundwater extraction system over a period of time. The O&M Manual is required in the approved Part 2 - Pumping and Discharge System and Part 3 - Interim Advanced Wastewater Treatment System Work Plan dated March 1991 (Part 2 and 3 Work Plan--see discussion in Section 1.2). This document fulfills this requirement.

This O&M Manual consists of three parts:

1) Volume I - Operation Methodology - This portion of the O&M Manual describes system objectives and management programs to help ensure that the system meets these objectives. These management programs are a design confirmation program, a monitoring program, and an evaluation/response program.

2) Volume II - Detailed Operation - This portion of the O&M Manual defines specific procedures associated with operation of the system equipment.

3) Volume III - Maintenance - This portion of the O&M Manual defines the specific procedures associated with maintaining the system equipment.

This predesign and preconstruction submittal of this document includes only portions of Volume I - Operation Methodology. Section 2 and certain specifics in Sections 3, 4, and 5 are not written at the present time because final information regarding hydrogeologic characterization and system design is not yet available. A subsequent submittal of this document will contain this information. In addition, Volume II - Detailed Operation, Volume III - Maintenance, and certain supporting appendices will be submitted prior to start up when as-built information regarding equipment is available. This early draft has been prepared to establish criteria and programs for system operation and to provide the regulatory agencies an opportunity to comment on the operating programs.

1.2 Background

Operable Unit 5 (OU-5) - Environmental Media, of the FEMP Remedial Investigation/Feasibility Study (RI/FS), includes those environmental media that serve as migration pathways and/or environmental receptors of radiological or chemical releases from the FEMP. RI/FS findings have determined that a uranium contaminant plume exists in an area outside of FEMP property to the south (see Figure 1-1). Because of the associated potential threats to human health and the environment, a removal action to address this plume outside of the FEMP boundary has been planned. The 1990 Consent Agreement between the DOE and the EPA, Section IX, A.3, requires the submission of a proposal for additional monitoring wells, Engineering Evaluation/Cost Analysis, and a work plan for the south plume removal action.

The Engineering Evaluation/Cost Analysis - South Plume (South Plume EE/CA) was initially submitted in May 1990; and after the public comment process (and resolution to the dispute between U.S. EPA and DOE), it was finalized in November 1990. The South Plume EE/CA selected alternative 4 which included groundwater pumping and discharge, an alternative water supply for two industrial users, installation of an interim advanced wastewater treatment system, and enhanced monitoring and institutional controls. The initial location of recovery wells, based on groundwater modeling simulations, was along New Haven Road just west of its intersection with State Route 128. (see Figure 1-1).

As a result of information obtained recently from a separate remedial investigation that is being performed at the Paddy's Run Road Site (PRRS), additional concerns have been identified in the South Plume area. The PRRS consists of several industries (e.g., Albright & Wilson Americas Co., and Rutgers and Nease) that, over the past years, have reportedly released both organics and inorganics into the environment which have now found their way to the Great Miami aquifer. Some of these contaminants include cumine, toluene, benzene, arsenic, mercury, and others. The PRRS plume has been determined to extend to very near the location of the proposed recovery well field as described in the November 1990 South Plume EE/CA. Therefore, operation of a uranium recovery well field at the location originally described could result in the extraction and discharge of PRRS contaminants to the Great Miami River (IAWWT system will only address uranium) and could result in the further spreading of the PRRS contaminants as has been predicted by computer modeling.

As a result of these conditions, it has been deemed necessary to relocate the Part 2 well field to an area north of the PRRS. Modeling efforts have been performed to determine a location where pumping of the recovery well field will not significantly affect the PRRS plume and will not draw PRRS contaminants into the recovery well field. In addition, it was necessary to alter the November 1990 South Plume EE/CA with an addendum which restructured the EE/CA objectives to accommodate these conditions.

This relocation of the Part 2 well field has generated several additional requirements. The new location is in an area of higher uranium concentration which jeopardizes the equivalent mass treatment concept as described in the November 1990 EE/CA. Accordingly, the Part 3 IAWWT system will be expanded in size to provide the additional treatment necessary to meet the previously agreed to equivalent mass concept.

In addition, the relocated well field is upgradient of an area of known 30 μg/l uranium contamination. The computer model for the south plume predicts that other areas could also exist where the level of uranium concentration is above 30 μg/l. Therefore, an additional investigation will be performed under a new Part 5 of the south plume removal action. The Part 5 investigation will include hydropunching and soil vapor survey of the area south of the well field to New Haven Road. The investigation will identify the location of the 30 μg/l uranium isopleth. Because the EPA has recently issued a proposed revised limit of 20 μg/l for uranium in drinking water, the investigation will also identify the location of the 20 μg/l isopleth. The information obtained will be used to allow the FEMP to limit access to this water until final remediation of this area is implemented.

Currently, it is envisioned that the remediation of the south plume will be addressed by dividing the area into 3 zones. The purpose of the zones are to distinguish the areas of contamination for purposes of treatment. The zones are as follows:

1) Zone 1 would be the area of aquifer containing only uranium as the contaminant of concern. This will be the area addressed by the south plume removal action project described in the EE/CA, as modified above.

2) Zone 2 would be the area of aquifer containing uranium, inorganics, and organics as contaminants of concern. This area will need to be addressed jointly by the FEMP and PRRS.

3) Zone 3 would include inorganics and organics as contaminants of concern. The area may also contain uranium contamination, but at a level below that specified in the FEMP Operable Unit 5 ROD. This area will need to be addressed solely by the PRRS, but will need to be coordinated with FEMP efforts for Zones 1 and 2.

1.3 Objectives

The South Plume EE/CA identified one primary and two secondary objectives for the south plume removal action:

1) Primary--Protection of public health by limiting access to and use of groundwater with uranium concentrations exceeding the derived concentration limit of 30 μg/l for uranium in drinking water, as well as other appropriate, risk-based levels for various potential exposure scenarios.

2) Secondary
   (1) Protection of the groundwater environment, which, in this case, is represented by a sensitive, sole-source aquifer.
   (2) Control of plume migration toward additional receptors further south.

(To be included after plume is redefined)

Figure 1-1 - Plan Showing South Plume

For the pumping and discharge system (Part 2) portion of the removal action, specific objectives need to be restated and expanded to take into account the impact of the PRRS and to clarify the specific performance criteria for evaluation of the system. The groundwater recovery system needs to meet--to the extent possible--the following four objectives:

1) The groundwater extraction wells need to be pumped at a sufficient rate to create a hydraulic barrier along a line running perpendicular to the longitudinal axis of the plume in the shallow portion of the Great Miami Aquifer, creating an elongated groundwater trough. This hydraulic barrier needs to extend sufficiently outward from the centerline of the plume to intercept the Zone 1 plume or contamination above the 30 μg/l total uranium level.

2) The magnitude of the hydraulic trough needs to be minimized while still meeting Objective 1 in order to minimize the impact on the overall hydrogeologic system. If extensive capture zones are created, then the PRRS plumes may be pulled toward the extraction wells. Also, minimal disturbance to the local hydrologic system is desired to prevent impacts on groundwater users in the area, to minimize the possible velocity increases of movement of on-site plumes, and to not significantly deflect the PRRS contaminant flow trajectory. The extraction wells, therefore, need to create a hydraulic sink to prevent plume movement by the wells and to minimize capture zones and large scale reversals of groundwater flow.

3) Contamination within the aquifer needs to be removed as soon as feasible to prevent further plume movement and degradation of the groundwater environment. Removal of contaminants near the source or in the shallow portion of the aquifer is more efficient and prevents further damage. The recovery system should be operated to prevent further spread of contamination.

4) The operation of the removal action recovery system needs to be consistent with the final site remediation. This standard is difficult because the final site remediation systems are unknown at the present time. However, probably the most relevant issue regarding impacts of pump and treat systems is the possible expansion of other plumes caused by increasing hydraulic slope, thus increasing potential spread of contamination. This issue is the basis of Objective 2 which requires the minimizing of impacts on the natural system.

To meet the multiple objectives requires that the system balance the two opposing factors of creating sufficient drawdown to prevent migration around, between, or beneath the recovery wells and of minimizing drawdown to prevent gradient changes over a large area. Therefore, the system must be evaluated in relation to balancing these objectives. The primary objective (Objective 1) will carry more weight. However, any recommended change to operation or design of the system needs to evaluate its impact on all the objectives.

1.4 Overview of the Operation Methodology

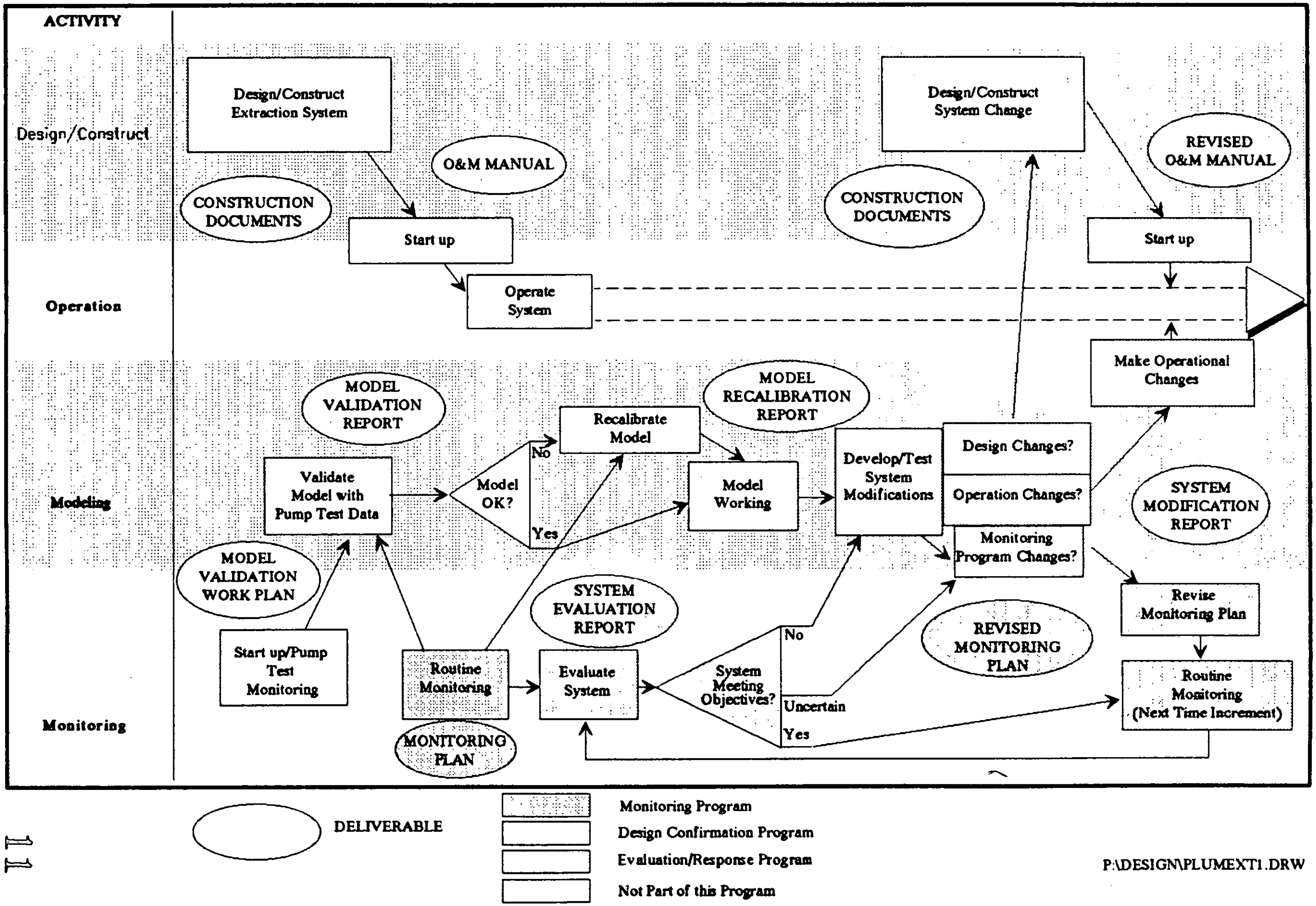
Figure 1-2 presents an overview of the program, defined in Volume I--Operation Methodology, to start up and operate the extraction system within the stated objectives. Four types of activities are defined as horizontal blocks across the page: design/construct, operation, modeling, and monitoring. Also, the three programs defined in this document: monitoring, design confirmation, and evaluation/response are defined by different colors. Deliverables associated with tasks are enclosed in ovals. Copies of these deliverables will be provided to USEPA and OEPA.

The purpose of the design confirmation program (represented as yellow blocks on Figure 1-2) is to test the design basis with a dynamic test of the system and adjust parameters based on the results of this test. The design confirmation program is described in detail in Section 3. This program consists of a pumping test at start up; validation of the groundwater model based on the results of the pump test; and model recalibration (if necessary) based on model validation, pump test results, and other monitoring data. Three deliverables accompany these activities:

1) Model Validation Work Plan
2) Model Validation Report
3) Model Recalibration Report (if necessary).

The purpose of the monitoring program (represented as green blocks on Figure 1-2) is to take environmental samples and measurements over time to provide data for the performance of the system. The monitoring program is described in detail in Section 4. This program consists of routine monitoring at specified intervals. The data collected will be fed into the evaluation/response program (see description below). The sitewide monitoring plan will be updated with additional provisions required for this removal action.

Figure 1-2
Operation Methodology Logic Diagram for the The South Plume Extraction System



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The purpose of the evaluation/response program (represented as blue blocks on Figure 1-2) is to analyze whether the system is meeting its objectives and to respond accordingly. The evaluation/response program is described in detail in Section 5. This program consists of periodic system evaluations; development of system modifications; and implementation of either design, operation, or monitoring program changes (as needed). Four deliverables accompany these activities:

1) System Evaluation Report
2) System Modification Report (if necessary)
3) Construction Documents (if necessary)
4) Revised O&M Manual (if necessary).

SECTION 2

TECHNICAL PROJECT SUMMARY

2.1 Introduction

(Later, to be included when design is finalized)

2.2 Hydrogeologic Summary

(Later, to be included when design is finalized)

2.3 System Design Summary

(Later, to be included when design is finalized)

SECTION 3

DESIGN CONFIRMATION PROGRAM

3.1 Introduction

A design confirmation program has been included within the O&M Manual to verify and improve (if necessary) the design/operation of the extraction system. Because of the high transmissivity of the aquifer and the extreme difficulties of managing large volumes of uranium-contaminated water, a site-specific pump test was not performed as the basis for the extraction system. However, since the groundwater model of the site is well developed and the hydrogeology of the Great Miami Aquifer in the vicinity of the south plume has been determined to be relatively simple, it was determined that the extraction system could be designed without a site-specific pump test, provided that operational flexibility is included within the design.

The start up of the groundwater extraction system provides an opportunity to perform a pump test since facilities will be available to manage the groundwater. Data from this pump test will be used to validate and recalibrate (if necessary) the model in the vicinity of the extraction wells. Specifics of these activities are described below.

3.2 Pumping Test

A constant rate pumping test will be conducted on one of the completed recovery wells. The model validation work plan will describe, in detail, rates, locations of pumped and observation wells, and pump test procedures. This section and Section 3.3 describe the philosophy and requirements for this work plan which is included as Appendix A (*to be included later*).

The pump test will be conducted near the maximum rate attainable (600 to 700 gallons per minute based on preliminary design information) in order to evaluate conditions over as large an area as possible. The test will be carried out for 72 hours or until water levels substantially stabilize. The maximum duration of the test will be 7 days. The particular well for testing will be selected based on representativeness of location (interior wells preferred) and depth, availability of monitoring points at comparable aquifer depths, and other system restrictions. Pump test water will be discharged through the new force main to the new FEMP Great Miami River outfall. This pump test will not be conducted until the Interim Advanced Waste Water Treatment Plant is operational.

A minimum of four monitoring wells or observation wells will be measured at prescribed intervals during the test. These wells may be existing monitoring wells, new monitoring wells associated with the south plume removal action, other recovery wells, or observations wells constructed for the test. These wells will be selected based on screen elevations, screen lengths, and well locations in respect to the pumped well.

The distance between these wells and the recovery well will be based on groundwater model simulations conducted for Part 5 of this work. Three wells will be in one direction from the recovery wells. Two of these wells will be in a couplet consisting of a 2000 Series (water table) and a 3000 Series (mid-aquifer) depth monitoring or observation well to define vertical gradients at this location. In the same direction, another 2000 series depth well will be monitored. The other observation well will be at 90 degrees to the orientation of the other three observation wells to indicate the shape of the cone of influence and anistrophic (preferred orientation) characteristics of the hydraulic conductivity distribution. If appropriately located, additional monitoring wells will also be utilized in the pumping test to further delineate the hydraulic conductivity distribution.

Water levels will be continuously measured with multichannel data loggers and strip recorders in the recovery well and in the selected observation and monitoring wells. These time intervals will be initially closely spaced; and as the test continues, they will be spaced further apart following standard pump test protocols. Water samples will be collected from the pumped well and selected monitoring wells at more widely spaced intervals and analyzed for total uranium. These water samples will be analyzed for temperature, specific conductance, and pH in the field to determine water chemistry changes during the test. It is projected that four samples will be taken the first day of the test and two samples on each of the remaining days.

Except as noted below, procedures for conducting the pump test and associated measurements, sampling, and analysis will be developed in accordance with the approved FEMP Quality Assurance Program Plan (QAPP). Because of the need for a quick response, site laboratories will be utilized for total uranium analysis. As a confirmation, 10 percent of the samples will be split and sent to laboratories approved in the FEMP QAPP.

Standard hydrogeologic software packages will be utilized to analyze the data and to determine hydraulic conductivity and storativity values. The data will also be analyzed for vertical flow characteristics and for the presence or absence of boundaries affecting flow.

3.3 Model Validation

The existing groundwater flow model will be validated by comparing the pump test hydraulic results with the groundwater model simulating the same conditions. This model validation will be performed during the first quarter after the system is operational so that a validated model may be used to help design system modifications in subsequent quarters. The model validation work plan describes in detail the evaluation criteria and validation procedures. (*to be included later as Appendix A*)

The recovery well and applicable monitoring and observation wells will be located on the existing groundwater model grid, and pumping will be simulated at the pump test actual flow. Other model assumptions such as depth of screen penetration of aquifer will be matched to field conditions to the extent possible. The model will be utilized in a transient mode to determine the changes over time in water levels at the recovery well and observation wells. The simulated changes and the pump test measured changes will be compared at applicable time intervals and in a steady state mode.

After the groundwater recovery wells are operational, a second experiment will be performed comparing the water elevations produced by the constant pumping of the recovery wells versus a modeled steady state simulation of these recovery wells pumping at this assigned rate. This data will become available after continuous operation of a month or more of the multiple recovery wells. Monthly water level readings during the first quarter of operation will be utilized for this test.

The results of the model validation will be described in a model validation report. Model versus pump test results will be analyzed and conclusions will be stated regarding the ability of the model to match the above two tests. Recommendations will also be made if warranted, regarding recalibration of the model.

3.4 Model Recalibration

If the model validation conclusions and recommendations deem it necessary, the model will be recalibrated in the vicinity of the south plume to approximate the conditions determined by the pump test and the model validation procedure. The recalibrated model will then be ready for use in supporting activities to develop system modifications.

Model recalibration will be conducted in accordance with procedures established in the RI/FS model work plan. Calibration criteria will be established prior to recalibrating the model. Repeated simulations using varying hydraulic conductivity distributions will be conducted to attempt to bring the model heads within the established calibration criteria. When the model has met the calibration criteria, two simulations will be run to confirm the new model assumptions. One, the pump test simulation matching the performed pump test will be rerun in transient and steady state modes, and the results will be compared and evaluated. Two, simulation of the recovery well pumping (of all wells) will be compared to the actual drawdown produced and measured (steady state). These results will also be compared and evaluated.

The calibration process is iterative and may require the adjustment of other parameters (infiltration, boundaries, etc.) in order to bring the model within the established criteria. A model recalibration report will be written which describes the recalibration assumptions, procedures, simulations, results, and which draws conclusions based on these results.

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SECTION 4

MONITORING PROGRAM

4.1 Introduction

Groundwater elevation and geochemical data will be collected at specified time intervals and locations to provide data for evaluating the system and to assist in validating and recalibrating the groundwater model. The sitewide monitoring program will be revised to include this additional monitoring, i.e., a separate monitoring plan will not be developed for the south plume removal action. This section describes the monitoring requirements for the routine monitoring program which will need to be incorporated in the sitewide monitoring program. Monitoring associated with the pump test is not included in this section but rather is described under the pump test.

4.2 Objectives

The objectives of the monitoring program for the south plume removal are

1) To delineate the cone of depression caused by the recovery wells
2) To provide supporting hydraulic data for the model validation and model calibration tasks
3) To delineate the uranium concentration distribution in the vicinity of the recovery wells
4) To anticipate the uranium concentrations that will be pumped in the future
5) To determine the potential impact of plumes from the Paddy's Run Road Site.

The following describes a program constructed to meet these objectives.

4.3 Water Level Measurements

Water levels will be measured at recovery wells, south plume monitoring wells, and selected additional monitoring or observation wells (see Table 4-1 and Figure 4-1). The frequency of these measurements will be as follows:

Time Increment	Frequency
1st week of operation	Daily
1st month of operation	Weekly
1st quarter of operation	Monthly
Subsequent operation	Quarterly

The above schedule of measurements has been selected to have more frequent data collection at the beginning of recovery pump operation because of transient effects. As operation continues and a relative steady state is achieved, the water levels will change less with time and quarterly readings will provide a picture of annual variation.

Monitoring wells in the area of the pumping wells will be measured for groundwater elevations to provide as complete a picture as possible.

Procedures for measuring water levels will be in accordance with the approved FEMP QAPP and the sitewide monitoring plan. The evaluation of this data is described in Section 5.

4.4 Geochemical Monitoring

Samples will be collected at recovery wells and south plume monitoring wells and will be analyzed for total uranium, pH, specific conductance, and temperature (see Table 4-1 and Figure 4-1). Selected monitoring wells will be sampled and analyzed for volatile organic compounds (VOCs) and inorganics in order to directly determine if the Paddy's Run Road Site organic or inorganic plume is expanding toward the recovery wells. These monitoring wells will serve as a barrier to provide advance information if the plume is migrating. Part 5 of the removal action will locate specific monitoring wells to provide this barrier monitoring and will identify specific indicator parameters for this monitoring.

The frequency of these measurements will be as follows:

Time Increment	Frequency
1st week of operation	Daily
1st month of operation	Weekly
1st quarter of operation	Monthly
Subsequent operation	Quarterly

Like the water level measurement program, more samples will be collected at the beginning of the program when there are more transient effects.

Except as noted below, procedures for sampling and analysis of monitoring wells will be in accordance with the approved FEMP QAPP and the sitewide monitoring plan. Because of the need for a quick response so that system evaluations and adjustments can be accomplished in a timely manner, on-site laboratories will be used for total uranium analysis. As a confirmation, 10 percent of the samples will be split and sent to laboratories approved in the FEMP QAPP. The evaluation of this data is described in Section 5.

Table 4-1 - Proposed South Plume Monitoring Program

	Water Levels	Total Uranium	pH, SC, T	VOCs	Inorganics
Recovery Well					
1	X	X	X		
2	X	X	X		
3	X	X	X		
4	X	X	X		
Monitoring Well					
1	X	X	X		
2	X	X	X		
3	X	X	X		
4	X	X	X		
5	X	X	X	*Selected based on locations*	*Selected based on locations*
6	X	X	X		
7	X	X	X		
8	X	X	X		
9	X	X	X		
10	X	X	X		
11	X	X	X		
12	X	X	X		
13	X	X	X		
14	X	X	X		
Observation Well					
1	X				
2	X				
3	X				
4	X				
5	X				
	X				

Notes: 1) Frequencies of sampling and measurements are stated in Sections 4.3 and 4.4.

2) *Table will be finalized once system is constructed. Well numbers are not actual numbers but are for program conceptualization only. Numbers of wells could also change.*

(To be submitted later, when design is finalized)

Figure 4-1 - Plan of South Plume Recovery, Observation, and Monitoring Wells

SECTION 5

EVALUATION/RESPONSE PROGRAM

5.1 Introduction

The purpose of the Evaluation/Response program is to analyze whether the system is meeting its objectives and to take appropriate action to bring it back in conformance with its objectives. Monitoring data will be utilized to evaluate whether the system is meeting its objectives. If this evaluation determines that the program objectives are being met, then no further action will be taken until the next monitoring period when the data is again evaluated. If the evaluation shows that the system is not meeting its objectives, then the model (and other analytical tools) will be utilized to develop modifications to bring the system in line with its objectives. Possible system changes may involve design, operation, or monitoring program modifications.

Because of spatial and temporal variations in the hydrogeologic system that is being analyzed, system evaluation and follow-on activities will be performed according to the following schedule:

Time Increment	Frequency
1st year	Quarterly
Subsequent years	Semi-annually

This schedule does not completely coincide with the monitoring schedule. Certain system evaluations will cover more than a single monitoring data set and will analyze available data sets at the time of evaluation.

5.2 System Evaluation

At each scheduled time interval, a system evaluation will be performed. The purpose of this evaluation is to determine whether the system is meeting the defined objectives. Since the criteria is primarily qualitative or perhaps semi-quantitative, the evaluation needs to analyze the data in several ways. Factors that will be considered include the following:

1) The present distribution of groundwater elevations in planar view and vertical section.

2) The change over time in the distribution of groundwater elevations.

3) The flow rate of pumping over the last evaluation cycle.

4) The rainfall over the last evaluation cycle.

5) Other aquifer stresses such as nearby production wells occurring over the last evaluation cycle.

6) The present distribution of uranium concentration in planar view and vertical section.

7) The change over time in uranium concentration.

8) The present distribution of PRRS organic and inorganic constituents.

9) The change-over time of PRRS organic and inorganic constituents.

10) Other geochemical factors.

Based upon the consideration of these factors, it will be determined whether the system is meeting its objectives. Statistical procedures will be used, as appropriate, to determine significance of changes. This evaluation will need to balance possibly competing objectives. This evaluation will need to be cognizant of time and spatial variability and will need to react to general trends but not to every possible system upset; i.e., a global approach needs to be taken. Conclusions and recommendations to this system evaluation may state that

1) the system is not meeting its objectives.

2) specific changes need to be made to the system to bring it in line with the objectives.

3) the monitoring program needs to be changed to determine if objectives are met. The evaluation may recommend the specific monitoring program changes (frequency, locations, parameters, etc.) that need to be made.

4) the system is functioning in accordance with its objectives and recommend that no changes be made.

5) the system has met its objective. The evaluation may recommend ceasing operation of the system and continuation of monitoring for a specified period as a confirmation.

A system evaluation report will be prepared containing the described analysis, conclusions, and recommendations.

5.3 Development of System Modifications

If recommended by the system evaluation report, an effort will be undertaken to develop system modifications. The groundwater model will be utilized to assist in this development effort by allowing the simulation of possible system changes and an analysis of the effects of these changes. Other analytical tools may also be used to assist in this effort.

Three types of system modifications are possible. These are described in the following sections.

5.3.1 Operation Changes

The preferred choice in modifying the system will be with an operating change. Specific operating changes include

1) varying the constant pumping rate of any pump. Different rates may be applicable to each pump depending on the identified need of the system.

2) instituting pulsed pumping (stop/start cycles) at any pump. Different pulsed pumping rates and intervals may be applicable to each pump depending on the identified need of the system.

3) turning off a particular pump depending on the needs of the system.

A system modification report will describe the simulations and analysis conducted to arrive at the selected operational changes. This report will also analyze the effect of the change on other parts of the removal action. Upon finalizing this report, the operational changes will be implemented by operating personnel.

5.3.2 Design Changes

If an operational change is unable to modify the system sufficiently to bring it in line with the objectives, then a design change may have to be conducted. Design changes typically will require that new recovery wells be added to the system with the location determined by the needs of the system. Design changes may dictate accompanying operational or monitoring modifications.

The system modification report will describe the simulations and analysis used to arrive at the design change and will recommend a particular system addition. Based on the recommendations of this report, detailed design activities will commence. Factors involved in the design include the procurement of easement, the need for ancillary equipment to support the new recovery well(s), and the schedule of design and construction.

The design agency will produce construction documents. The job will be bid and a construction contractor will be selected. The construction contractor will construct the new system component, and another startup procedure will commence. The O&M Manual will be updated to reflect the new components in the system.

5.3.3 Monitoring Program Changes

Changes in the monitoring program may be recommended directly from the system evaluation report or may be recommended in the system modification report (see Figure 1-2). Monitoring program changes do not necessarily need to go through a system modification development since changes could be very routine (for example, adding a parameter, an existing well, or changing a sampling frequency). Other monitoring program changes may accompany an operational or design change to match the monitoring program to the new system parameters. New monitoring wells will require a minimal design activity since established procedures will be followed. Increased frequency of monitoring during start up may be required to accompany a major system change.

The sitewide monitoring program will need to be changed or amended when monitoring program changes are prescribed.